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An updated inventory of the vascular flora of Elba island (Tuscan Archipelago, Italy)

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Abstract

We present an updated list of the vascular flora occurring on Elba island (Tuscan Archipelago). The list is based on bibliographic analysis and field studies carried out in the years 2006–2018. With a total of 1,098 specific and subspecific taxa currently occurring on the island (including 101 naturalized aliens), plus 67 casual aliens and 16 hybrid taxa, Elba shows the highest number of species among the islands of the Tuscan Archipelago. Two taxa are new for Tuscany: *Hieracium symphytaceum* s.l. and *Ophrys exaltata* subsp. *morisii*; 22 taxa are new for the island, 34 have been confirmed, while 326 were reliably recorded previously by other authors, but not confirmed by our study. We excluded 41 taxa and considered doubtful the occurrence of 87. Life forms and chorotypes are in agreement with the Mediterranean climate of the island. Despite this, Elba also hosts a considerable proportion of Eurosiberian taxa. We detected significant differences in chorotypes and life forms spectra among different geographical portions of the island, paralleling distinct bioclimatic patterns. Despite the institution of the Tuscan Archipelago National Park, we are still far from an integrated protection of the island flora. Based on our results, it has been possible to arrange a geodatabase of the flora on the island, useful for its protection.

Keywords

alien species, biodiversity, endemics, floristic data, Italy, phytogeography, Tuscany

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Introduction

A flora is a useful source of information for biogeographical, ecological and evolutionary studies (Peruzzi 2018 and literature cited therein) and thus, floristic inventories and the analyses of plant species distribution across a geographic area are crucial to provide suitable data for decision-making processes in biodiversity conservation and landscape planning (Luque 2000, Heywood 2017, Thomson et al. 2018).

Particularly, islands have long served as an inspiration for evolutionary hypotheses because their biotic assemblages and ecological processes are clearly delimited by geographical constraints (MacArthur and Wilson 1967, Whittaker and Fernandez-Palacios 2013). Islands are indeed not simply miniature continents (Nunn 2004): they host peculiar and often unique and vulnerable floras.

The Mediterranean Basin is recognised among the most altered hotspots of biological diversity worldwide (Myers et al. 2000). Traditional, long established land use practices in the Mediterranean significantly contributed to the current biological and landscape features (Blondel 2006, Baiamonte et al. 2015). However, significant land use changes mainly associated with a switch from a traditional economy based on agriculture towards an industrial or tourism economy took place since the end of World War II (Vogiatzakis et al. 2008). The effects of land use changes on islands are often stronger than those observed on mainland areas (Delanoë et al. 1996).

The Tuscan Archipelago consists of seven islands and about twenty islets midway between mainland Italy and Corsica (France), and is one of the most interesting areas in the Central Mediterranean area from a naturalistic point of view (Arrigoni et al. 2003, Carta et al. 2013). Despite this, it has been strongly affected by socio-economic changes. All islands have been explored several times by botanists over the last centuries. Between the 19th and 20th centuries, the first comprehensive study on the Tuscan Archipelago flora was published (Sommier 1902, 1903): one of the first studies devoted to a group of small islands (Greuter 1995). With a total area of 220 km^2, Elba is the largest of all islands forming the Tuscan Archipelago. The island reaches a maximum altitude of 1,019 m a.s.l. (Monte Capanne) and shows a high geomorphological variability, leading to the establishment of three distinct bioclimatic belts and a large vegetation diversity (Foggi et al. 2006). Since 1996, over half of the territory is included within the Tuscan Archipelago National Park. Nevertheless, during the last decades, the island experienced a socio-economic transition from an economy largely based on traditional agricultural exploitation to an economy based on tourism, which determined a substantial land use shift (Carta et al. 2018b). This land use shift was paralleled by significant floristic changes mostly due to an increase in the number of alien species (Chiarucci et al. 2017). Altogether, these conditions make Elba an interesting place to study plant assemblages and drawing up an updated floristic inventory.

Starting from the mid-1900s, several studies were devoted to the flora of the Elba island (Fossi Innamorati 1983 and literature cited therein), including two excursions of the Italian Botanical Society (Negri 1950, Signorini et al. 2002), and the completion of a floristic prodrome for the island (Fossi Innamorati 1983, 1989, 1991,

1994, 1997), mainly based on a critical review of the collections made by S. Sommier. Thereafter, several floristic (Mannocci 2004, 2009, Bertacchi et al. 2005, Frangini et al. 2005, 2006, Borzatti de Loewenstern and Mannocci 2008, Foggi et al. 2015), vegetation (Foggi et al. 2006, Carta 2009), and taxonomic (Signorini and Foggi 1998, Peruzzi and Carta 2011, 2013, Ardenghi et al. 2014) studies were published. Also a recent list of names (Chiarucci et al. 2017) was published, however lacking a comprehensive analysis of previous literature and lacking a synthesis using an updated and coherent nomenclature. Hence, the aim of our study is to finalise an updated inventory of vascular flora on Elba island by tracking the current and past records of taxa, possibly identifying their distribution on the island, taking into account recent socio-economic changes that have significantly changed the landscape and the flora. In addition, to analyse more deeply plant distribution patterns, the island was subdivided into 12 bioclimatically homogeneous sectors in which we recorded plant occurrences and thereafter evaluated environmentally driven effects on species number, historical distribution, chorology and life form spectra.

Material and methods

Floristic inventory

We searched all published papers dealing with plants on Elba island and extracted occurrence records for all those species reported for the island. Smaller islets around Elba island were not considered because their flora was already studied and published by Foggi et al. (2009a). In addition to the papers cited in the Introduction, the following references were checked: Koestlin (1780), Thiébaut De Berneaud (1808), Caruel (1860, 1870), Bolzon (1893, 1894), Baroni (1897–1908), Fiori (1923–1929, 1943), Corti (1940), Marcello (1951), Ottens (1967), Arrigoni (1976, 2016, 2017), Jalas and Suominen (1976), Paoli and Romagnoli (1976), Zangheri (1976), Viegi and Cela Renzoni (1981), Pignatti (1982a-b), Nardi (1984), Natali (1988), Banfi (1989, 2017), Landi (1989), Gatteschi and Arretini (1990), Alessandro et al. (1991), Corsi and Garbari (1991), Baldini (1993), Del Prete and Tosi (1994), Bussotti et al. (1997), Hofmann et al. (1998), Rizzotto (1999), Vagge and Biondi (1999), Rinaldi (2000), Breiner and Breiner (2001, 2002), Del Prete (2001), Adamoli and Rigon (2003), Pignotti (2003), Ackermann and Ackermann (2004), Frangini (2004), Group of European Pteridologists (2004), Fanelli and Tescarollo (2005), Frangini et al. (2005, 2006), Tavormina (2006), Atzori (2007), Barsotti (2008), Bedini et al. (2008), Guiggi (2008, 2014), Hoffmann and Hoffmann (2008), Iamonico et al. (2008, 2011), Foggi and Venturi (2010), Arrigoni and Viegi (2011), Frignani and Iiriti (2011), Ferretti and Foggi (2013), Ferretti et al. (2013), Lazzaro et al. (2013a-b, 2014a-b), Ardenghi et al. (2014, 2015), Bagella et al. (2015), Cecchi and Selvi (2015), Iamonico (2015), Signorini and Tani (2015), Roma-Marzio et al. (2016, 2017), Scoppola et al. (2016), Benítez-Benítez et al. (2017), Martini and Viciani (2018), Troia et al. (2018).

Besides the occurrence on the island, the collecting site was also recorded; localities reported on historical publications or herbarium labels were attributed to one or more of the identified operational geographic units (see below). Literature search was complemented by several field surveys carried out during the years 2006–2018 across the whole island; some sites (e.g., low altitude western slopes of Monte Capanne, Capoliveri mines) were visited multiple times during the same year, matching distinct flowering times across the seasons; other sites (e.g., Cala del Pisciatoio, Mola) were specifically visited to verify historical records or to explore under-sampled areas (as emerged from literature analyses). Our most relevant floristic findings were published during the research: Carta (2007, 2010a-b, 2011a-b, 2012, 2015), Carta et al. (2008, 2009, 2010a-b, 2011, 2012a-b, 2013), Carlesi and Peruzzi (2010), Carta and Frangini (2010, 2013), Frangini et al. (2010), Frangini and Carta (2011, 2012), Galasso et al. (2011, 2017), Iamonico and Forbicioni (2011), Forbicioni and Frangini (2012), Gonnelli et al. (2012), Pierini and Peruzzi (2012), Langeneck and Peruzzi (2013), Peruzzi et al. (2009, 2013, 2014, 2017), Forbicioni et al. (2014), Pierini (2014), Carta and Peruzzi (2015).

Nomenclature and circumscription of the taxa follow Bartolucci et al. (2018) and Galasso et al. (2018); angiosperm families are arranged according to APG IV (2016). According to the former authors, for coding the occurrence status of each taxon on Elba island, we refer to the following categories: Doubtfully occurring: "D"; No longer recorded (reliable historical record): "NC"; Recorded by mistake: "NP". Native (or putatively native) plants are in bold in the list; naturalized alien plants are not in bold, while casual aliens and/or cultivated taxa, but also NP taxa, are in italics. The new records for the island are marked as "New", while taxa confirmed for the island in this contribution are marked by the symbol "*". Life forms and chorotypes were attributed according to Pignatti (1982a). The complete dataset assembled for the present study is available in Suppl. material 1.

Temporal, spatial and statistical analyses

The OGUs were identified based on bioclimatic (see Foggi et al. 2006 for further details) and geographical features of the island. Each OGU is labelled by a combination of a number (1, 2, 3) and a letter (a, b, c, d, e). The numbers distinguish the western (1), central (2), and eastern (3) portion of the island, recalling a previous attempt (Arrigoni et al. 2003) to identify the western part of the island as more influenced by Western-Mediterranean Sardinian-Corsican taxa compared to the eastern one. The letters identify different ecological belts (Fig. 1). For analytical purposes, plant occurrences were assembled in two main periods (before 1950 and after 1950) and in twelve sectors (Operational Geographic Units, OGUs thereafter) (Fig. 1); species recorded in a given OGU before 1950 is indicated with an "s" ahead the label of the sector and considered as historical. We selected this temporal threshold because of the socio-economic transition experienced by the island after the 1950s.

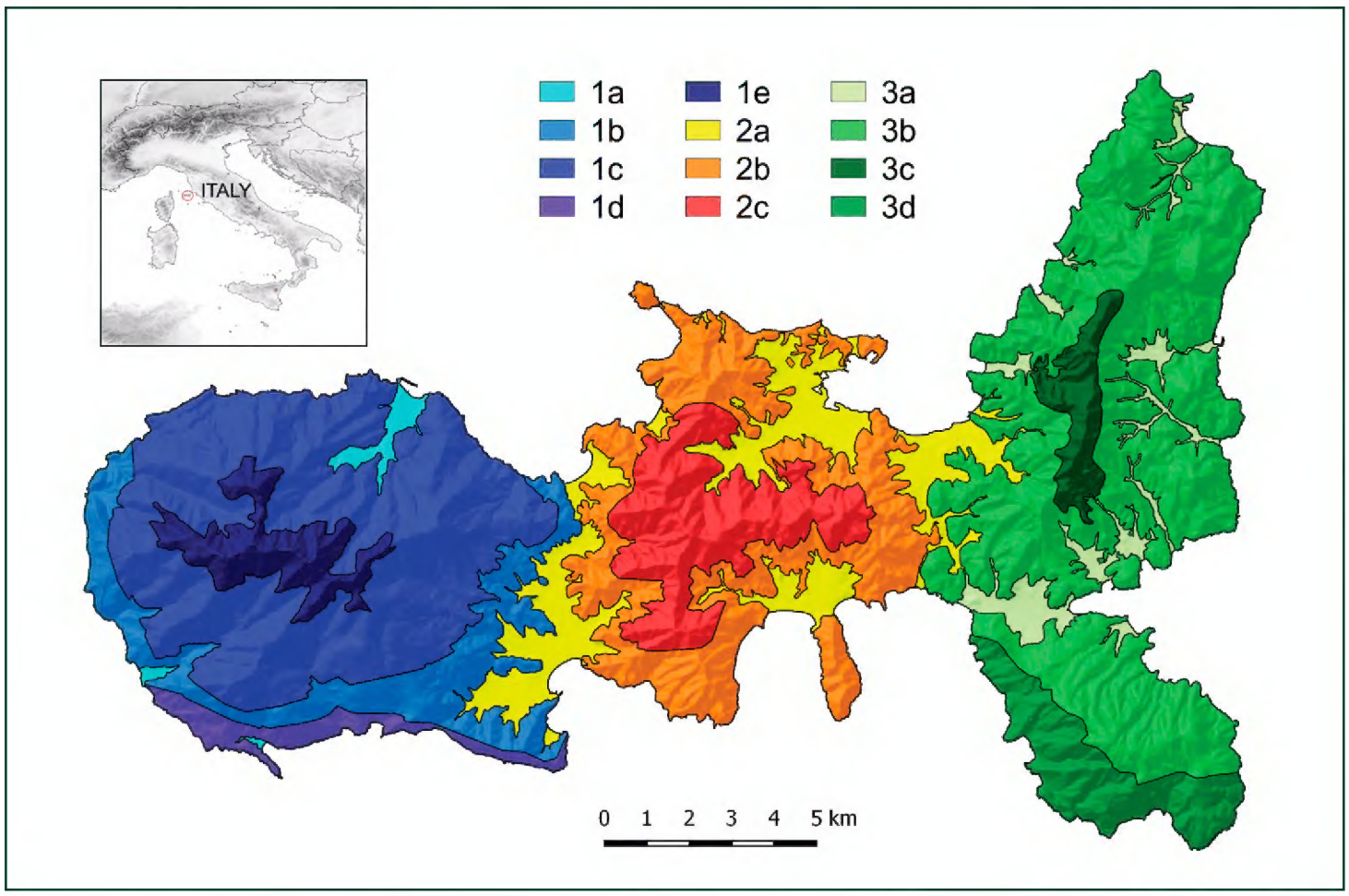

Figure 1. Localisaton of Elba island (red circle) in the Central Mediterranean area and subdivision of the island into 12 Operational Geographic Units. The numbers distinguish the western (**1**), central (**2**), and eastern (**3**) portion of the island, while the letters distinguish ecological belts as follows: (**a**) alluvial plains, stream banks and shores, (**b**) hilly areas below 250 m a.s.l., mostly characterised by a mesomediterranean thermotype and a subhumid ombrotype, (**c**) hilly and mountain areas generally above 250 and below 700 m a.s.l. characterised by mesomediterranean thermotype and humid ombrotype, (**d**) coastal hilly areas with a thermomediterranean thermotype, and (**e**) mountain areas above 700 m a.s.l. characterised by mesomediterranean and supramediterranean thermotypes.

To assess whether observed frequencies of categorical variables (historical occurrence, taxonomic rank, chorology, and life form) differ significantly from theoretical expectations, we used χ^2 tests. In addition, to determine whether there was a significant association between two categorical variables (among those listed above), we also applied a χ^2 test of independence or simple multinomial logit model (for binary categories, namely confirmation). All analyses were performed with the software R (R Development Core Team 2017).

Results

Floristic inventory

A total of 1,098 specific and subspecific taxa currently occur on the island, including 101 naturalized aliens, representing about 9% of the flora, not considering casual aliens

(67) and hybrid taxa (16); *Hieracium symphytaceum* Arv.-Touv. s.l. and *Ophrys exaltata* Ten. subsp. *morisii* (Martelli) Del Prete are new records for Tuscany, and 22 taxa are new for the island (including 3 naturalized and 5 casuals aliens); among them, *Galium verrucosum* Huds. subsp. *halophilum* (Ponzo) Lambinon and *Verbascum conocarpum* Moris subsp. *conocarpum* are of particular relevance. While 34 taxa have been directly confirmed during field surveys (e.g., *Bellevalia romana* (L.) Sweet, *Cerinthe major* L. subsp. *major*, *Lamium purpureum* L.), 326 taxa reliably recorded in the past were not confirmed (e.g., *Asplenium sagittatum* (DC.) Bange, *Thelypteris palustris* Schott, *Nymphaea alba* L., *Sagittaria sagittifolia* L., *Hypecoum procumbens* L. subsp. *procumbens*, *Lotus conimbricensis* Brot.). We excluded 41 taxa (e.g., *Oxalis acetosella* L., *Romulea insularis* Sommier, *Rosa rubiginosa* L.), and considered doubtful the occurrence of 87 taxa (e.g., *Allium parciflorum* Viv., *Briza media* L., *Polygala flavescens* DC. subsp. *flavescens*, *Soleirolia soleirolii* (Req.) Dandy). Overall, neither our direct field effort nor field researches conducted around the 1950 temporal threshold (Negri 1950, Marcello 1951) had a significant effect on current floristic diversity ($p > 0.05$).

Concerning the distribution of floristic diversity, while for 12 taxa a detailed distribution on the island is not available, 3b, 1c, and 2a show, respectively, 589, 546 and 540 taxa, and are the OGUs hosting the highest number of taxa. Floristic diversity is largely comparable among western (1), central (2) and eastern (3) portions of the island, but shows significant differences ($p < 0.001$) among ecological belts, with (d) and (e) being the poorest ecological belts, while (c), and especially (b), are the richest.

Considering the whole island, three families alone cover more than 30% of the total vascular flora (Asteraceae 124, Fabaceae 116, and Poaceae 112). However, an analysis by OGUs revealed that Fabaceae is the most represented family, showing in all sectors slightly more taxa than Asteraceae. The most represented genera are *Trifolium* (35), *Vicia*, and *Carex* (20).

Biological and chorological spectra highlight that therophytes (39%), hemicryptophytes (27%), and geophytes (15%) are the most represented life forms, while Mediterranean (47%), Euro-Mediterranean (24%), and Eurosiberian (11%) are the most frequent chorotypes. Alien taxa represent 6% of the total flora.

Italian endemics (Peruzzi et al. 2014, 2015, Bartolucci et al. 2018) are 26: 11 taxa show wide Italian distribution: *Biscutella maritima* Ten., *Carex microcarpa* Bertol. ex Moris, *Crocus biflorus* Mill., *Genista desoleana* Vals., *Helichrysum litoreum* Guss., *Ophrys appennina* Romolini & Soca, *O. classica* Devillers-Tersch. & Devillers, *O. crabronifera* Mauri, *O. exaltata* Ten. subsp. *montis-leonis* (O.Danesch. & E.Danesch) Soca, *O. tenthredinifera* Willd. subsp. *neglecta* (Parl.) E.G.Camus, and *Ornithogalum etruscum* Parl. subsp. *etruscum*; 6 taxa are Sardinian-Corsican-Tuscan Archipelago endemics: *Hypericum hircinum* L. subsp. *hircinum*, *Ophrys exaltata* subsp. *morisii*, *Pancratium illyricum* L., *Sagina revelierei* Jord. & Fourr., *Stachys salisii* Jord. & Fourr, and *Verbascum conocarpum* subsp. *conocarpum*. Just 1 taxon is endemic to Tuscan Archipelago (*Linaria capraria* Moris & De Not.), while 8 taxa are narrow endemic to Elba: *Biscutella pichiana* Raffaelli subsp. *ilvensis* Raffaelli, *Centaurea aetaliae* (Sommier) Bég., *C. ilvensis* (Sommier) Arrigoni, *Crocus ilvensis* Peruzzi & Carta, *Festuca gamisansii* Kerguélen

subsp. *aethaliae* Signorini & Foggi, *Hieracium elbanum* Belli ex Baroni, *Limonium ilvae* Pignatti, and *Viola corsica* Nyman subsp. *ilvensis* (W.Becker) Merxm.

Further 19 taxa occurring on the island are of high phytogeographical interest: *Cymbalaria aequitriloba* (Viv.) A.Chev. subsp. *aequitriloba*, *Dorycnopsis gerardii* (L.) Boiss., *Dryopteris tyrrhena* Fraser-Jenk. & Reichst., *Eudianthe laeta* Rchb. ex Willk., *Gagea granatellii* (Parl.) Parl., *Fumana scoparia* Pomel, *Isoëtes gymnocarpa* (Gennari) A.Braun, *Mesembryanthemum nodiflorum* L., and *Urtica atrovirens* (Req.) Loisel. are at the margin of their distribution range on Elba Island, while *Carex paui* Sennen, *Cosentinia vellea* (Aiton) Tod. subsp. *vellea*, *Gennaria diphylla* (Link) Parl., *Juncus ranarius* Songeon & E.P.Perrier, *Oeosporangium pteridioides* (Reichard) Franser-Jenk. & Pariyar, *Phalaris elongata* Braun-Blanq., *Poa perligularis* H.Scholz, *Sedum brevifolium* DC., *Stachys marrubiifolia* Viv., and *Thymbra capitata* (L.) Cav. can be found in Tuscany only on Elba Island (Peruzzi and Bedini 2015 onwards).

Temporal and spatial analyses

Taxa confirmations are not equally distributed among life forms, chorotypes, and OGUs (Figs 2, 3). Not confirmed taxa are significantly more abundant (significance level $p < 0.001$) among therophytes and especially hydrophytes, but also ($p < 0.001$) within the Eurosiberian chorotype. The portion of the island with less confirmed taxa is the sector 2, especially within belt (b). Whilst taxa confirmations resulted equally distributed ($p > 0.05$) among families, Apiaceae, Boraginaceae, Caprifoliaceae, and Fabaceae show respectively 37%, 20%, 30% e 25% of not recently confirmed taxa.

Families are mostly equally distributed ($p > 0.05$) among sectors and belts. Life forms and chorotypes are however not equally distributed ($p < 0.001$) among families. Lamiaceae and Plantaginaceae well represent chamaephytes (12% each, after excluding the three richest families), Orchidaceae and Amaryllidaceae prevail among geophytes (26% and 11% respectively), Alismataceae dominate the hydrophytes (21%), and Rosaceae dominate the nanophanerophytes (26%). Taxa showing wide (cosmopolitan/subcosmopolitan) distribution prevail in Poaceae, while Fabaceae are especially common among Mediterranean taxa (16%), and Asteraceae prevail within the Eurosiberian chorotype (11%).

Life forms are significantly associated ($p < 0.001$) with chorotypes: Mediterranean taxa are mostly represented by therophytes (46%), and Eurosiberian taxa are mostly represented by hemicryptophytes (40%). Italian endemics are mostly hemicryptophytes (39%) and geophytes (34%), while alien taxa are mostly represented by phanerophytes and therophytes (more than 60% altogether).

Life forms are also significantly associated ($p < 0.001$) with OGUs (Fig. 2), particularly: chamaephytes are especially frequent (37%) on belt (b) and hydrophytes on belt (a) (71%); therophytes are underrepresented in 1e (around 35%; exceeding 40% in all other OGUs), and hemicryptophytes dominate 1e and the OGUs of belt (c).

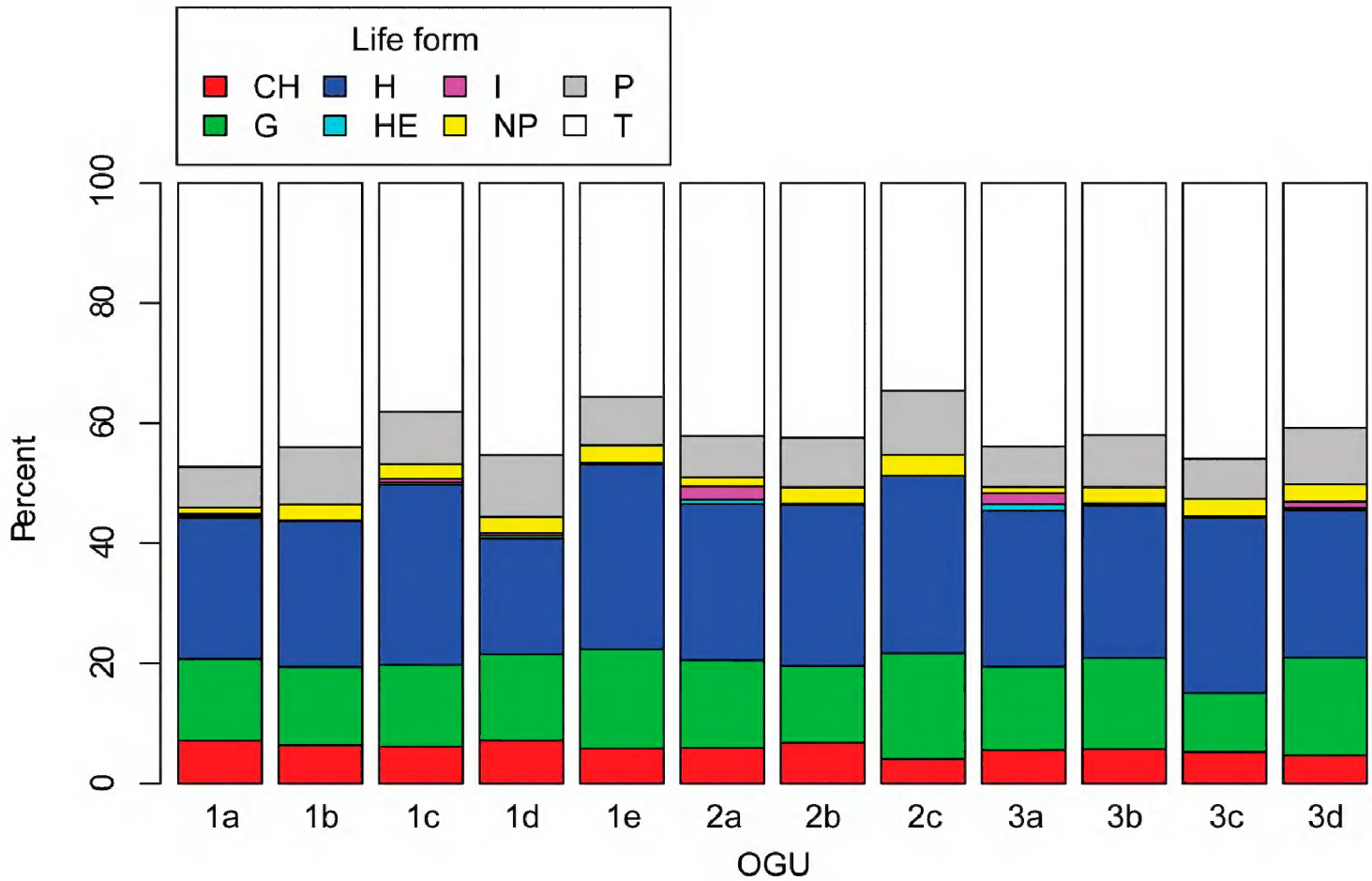

Figure 2. Life form spectra for each Operational Geographic Unit. CH = Chamaephytes, G = Geophytes, H = Hemicryptophytes, HE = Helophytes, I = Idrophytes, NP = Nanophanerophytes, P = Phanerophytes, T = Therophytes.

Chorotypes are also significantly associated ($p < 0.001$) with the OGUs (Fig. 3), with 1e particularly characterised by Italian endemics (5.5%), while the warmest and most urbanised OGUs (1a, 1d, 2a, 2b, 3a, 3b, and 3d) are associated with the occurrence of aliens. Finally, Eurosiberian taxa are underrepresented (less than 2%) in the warmest OGUs (1d and 3d).

Discussion

With a total of 1,098 specific and subspecific taxa currently occurring on the island, Elba is confirmed as the island hosting the highest number of vascular taxa in the Tuscan Archipelago. This is mostly due to the larger extension of Elba compared to other islands (Chiarucci et al. 2017), but also to a larger geological and bioclimatic variability leading to higher habitat and niche diversity (Foggi et al. 2006, Carta et al. 2013). However, further analyses based on species-area relationship are required to disentangle the main ecological factors driving plant richness (D'Antraccoli et al. 2017), and possibly plant diversity (Carta et al. 2018a), on Elba island. In order to ascertain whether Elba can considered as a vascular plant diversity centre (see Carta et al. 2018a for pteridophytes), the data published here should be analysed by means of phylogenetic comparative methods.

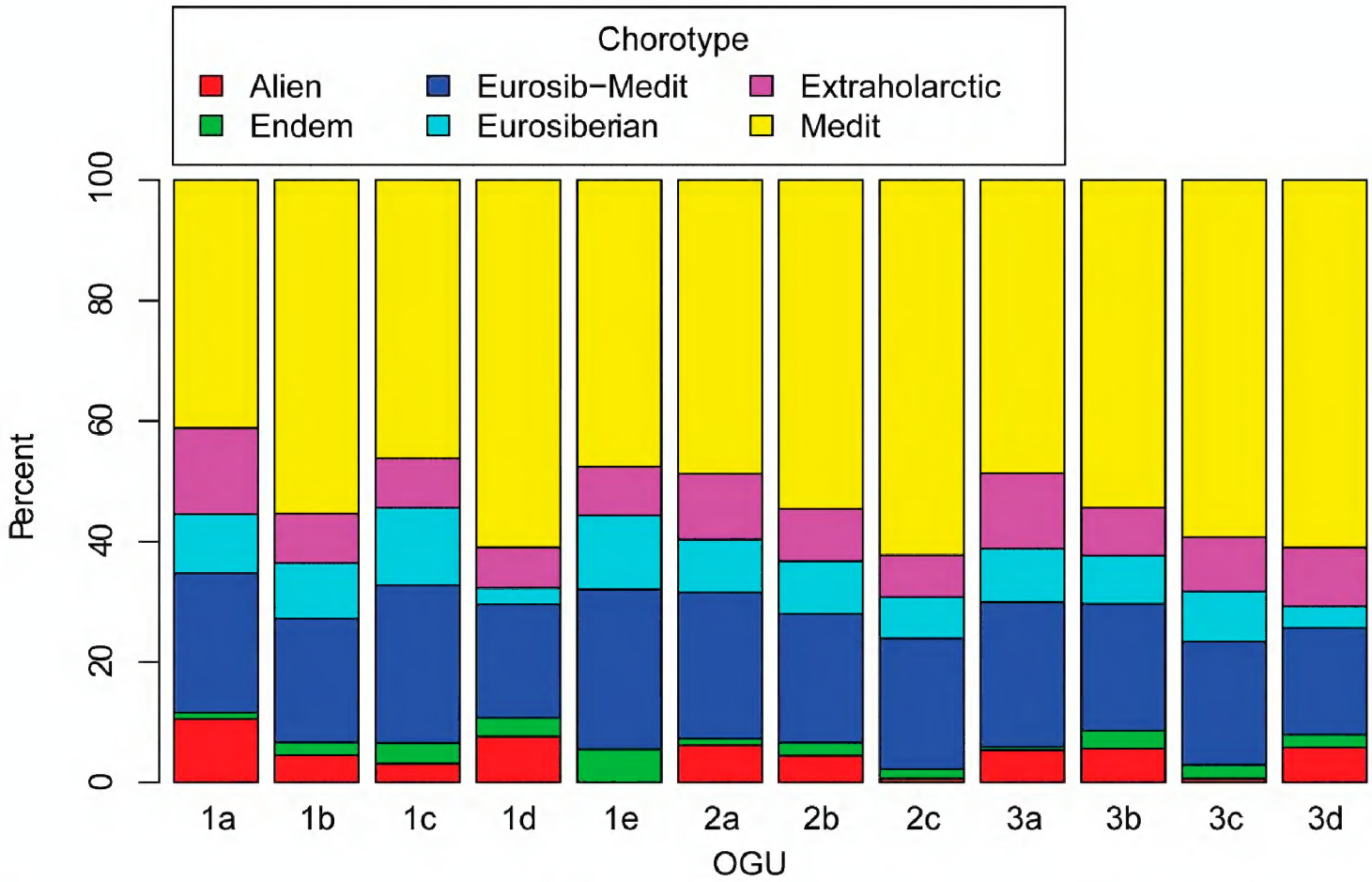

Figure 3. Chorological spectra for each Operational Geographic Unit. Alien = alien species, Endem = Italian endemic species, Extraholarctic = species showing range larger than Holarctic floristic kingdom, Eurosiberian = species showing range within the Eurosiberian floristic region, Eurosib-Medit = species showing range across Eurosiberian and Mediterranean floristic regions, Medit = species showing range within the Mediterranean floristic region.

The overall analysis of life forms and chorotypes revealed that the major component of the flora reflects the Mediterranean setting of the island and the prevalence of anthropogenic, secondary forms of vegetation (Arrigoni et al. 2003), belonging to the evergreen oak series (Foggi et al. 2006). Indeed, the most frequent life forms include herbs that especially grow in open, sunny habitats derived from the degradation of woodlands. Human influence has been massive since Roman times, but the vegetation has recently evolved towards more structured communities after the decrease of mining and agricultural activity (Carta et al. 2018b), possibly leading to a reduction of annual species (Chiarucci et al. 2017). However, it should be highlighted that 33 taxa considered as extinct or not recently confirmed by other authors (Fossi Innamorati 1997, Bertacchi et al. 2005, Chiarucci et al. 2017) have been eventually confirmed in our study. Nevertheless, our analysis highlights that the overall species confirmation is not depending from a single research group, but from several researchers separately active and in different times (especially after the world war II).

Elba hosts around 80% of the flora of the entire Tuscan Archipelago (Arrigoni et al. 2003, Carta et al. 2013), making any attempt to compare floras among Archipelago islands rather superfluous. However, besides being characterised by typical Mediterranean features, the flora of Elba also hosts a considerable proportion of Eurosiberian

taxa, largely not occurring on other islands. On the contrary, the flora of temporary wet habitats (Carta 2009) is also well represented in other islands of the Archipelago, especially in Capraia (Foggi et al. 2009). Shrubs and nanophanerophytes (Lamiaceae, Plantaginaceae, and Rosaceae) are linked with mesophilous habitats and are more common on Elba than in other islands. The ruderal flora associated with cultivated lands, and often represented by several crop wild relatives, is well represented on the island. However, we were not able to quantify it and further analyses are required to assess the influence of current agricultural activities on the survival of the species belonging to this peculiar flora and to make comparisons with other islands (especially Pianosa, for its long standing cultivations, see Baldini 2000).

The problem of alien species has already been highlighted by Chiarucci et al. (2017), and the number of aliens after our study is even higher than previously reported (84 naturalized and 45 casual aliens in Chiarucci et al. 2017, 101 naturalized and 67 casual aliens in our study). The total flora also including casual aliens lists 1,166 taxa, while Chiarucci et al. (2017) listed 1,013 and Fossi Innamorati (1997) 1,396 taxa. Nevertheless, Chiarucci et al. (2017) also include several species considered here as doubtful and especially lack a coherent nomenclature, while Fossi Innamorati (1997) include in the published number doubtful, not confirmed and even reported-by-mistake taxa. When all these categories are also included, our inventory exceeds 1,500 taxa, so that we conclude that these differences with previous published floras are illusory, or mostly linked to the recent acquisition of alien taxa.

The OGUs hosting the higher number of species (3b, 1c, 2a) are also the largest ones (Fig. 1). Nevertheless, we showed that plant species are non evenly distributed on the island, and the analyses suggest that the main factor influencing plant distribution is indeed local climate. A turnover analysis (Legendre 2014) would be needed to clearly demonstrate plant distribution variation among OGUs, but we detected significant differences in chorotypes and life forms spectra among OGUs, reflecting an altitudinal/bioclimatic trend (especially 1b > 1c > 1e). Furthermore, sectors 1d, 1e, 2a, and 3a host a peculiar flora compared to other sectors for climatic and edaphic reason. While 1d is particularly rich in xeric taxa, sectors 2a and 3a host the largest number of aquatic or wetland plants, even if in these alluvial sectors the fresh and brackish water habitats have been strongly reduced from past decades (Carta et al. 2018b).

OGU 1e, besides hosting a flora with temperate features, also hosts the majority of Italian endemics, albeit a few endemics are however also occurring in coastal habitats (*Limonium ilvae*) or in rocky cliffs spread across the island (*Linaria capraria*). Although it is difficult to reconstruct the geological events that possibly provided past links between Elba and other territories, some endemics show clear taxonomic relationships with the Sardinian-Corsican flora (Signorini and Foggi 1998, Borzatti de Loewenstern and Mannocci 2009, Carta and Peruzzi 2015) while others show a clear relationship with the Italian peninsula (Arrigoni 2003, Peruzzi and Carta 2011). Furthermore, several authors (Arrigoni 1976, Arrigoni et al. 2003, Carta et al. 2013, Foggi et al. 2015) repeatedly reported a higher western-Mediterranean (and especially Sardinian-Corsican) phytogeographical affinity for the western portion of the island

compared with the eastern one. Despite this, we did not detect significant differences in the major chorotype proportions between these two geographical sectors.

Conclusions

In spite of the institution of the Tuscan Archipelago National Park, including several specific *in situ* and *ex situ* conservation activities (Carta et al. 2012c, Foggi et al. 2015), we are still far from an integrated protection of the island flora. Based on our results, it has been possible to arrange an updated geodatabase of the flora on the island useful for its protection (Peruzzi and Bedini 2015 onwards). To this end, however, a landscape management plan avoiding land-use polarization through tourism, especially along the coast, promoting instead traditional use of woodland and agricultural activities should be promoted. Challenges remain at the policy level, particularly the decision making process and the opportunity to better define the role of science and protected areas in plant diversity conservation.

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Supplementary material 1

Supplementary data

Authors: Angelino Carta, Leonardo Forbicioni, Giuliano Frangini, Brunello Pierini, Lorenzo Peruzzi

Data type: specimens data

Explanation note: 1. Floristic list and records. 2. Toponyms arranged by Operational Geographic Unit.

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